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ABSTRACT

Computer-assisted instruction, when properly designed, can help students retain more of what they learn by requiring them to use more of their senses in the learning process. Although they are not without drawbacks, microcomputers can be effective teaching aids. They can assist teachers by performing routine clerical tasks (grading and recordkeeping), serving as an audiovisual device, and providing access to large educational databases and computer systems. Microcomputers can also assist vocational administrators by allowing them to formulate and revise budgets quickly, perform all the normal business functions entailed in administering a vocational education program, and keep in constant communication with other administrators and with state education officials via modem. Computer-assisted and computer-managed instruction allow vocational educators to individualize instruction. The key to all of these applications, however, is that teachers be given sufficient released time to learn to make full use of the potential of microcomputers, learn what types of software are available, and spend the evaluation time necessary to select the best software for their individual programs. Video technology, interactive videodisk technology, and optical laser disks also offer great promise in that they allow for the merging of the best of the worlds of audiovisual and computer-assisted instruction. As in the case of microcomputers, the problem with using videodisk technology in education remains the lack of availability of appropriate disks and software. The only way to circumvent the barrier imposed by the great cost of producing such software is to spread the cost over greater numbers of students or, in other words, to increase collaboration and sharing of materials among vocational educators. (MN)

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USING TECHNOLOGY FOR INSTRUCTION IN VOCATIONAL EDUCATION

PRECONFERENCE WORKSHOP
ADVANCED INSTRUCTIONAL TECHNOLOGY

October 6, 1987

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PREFACE

A number of "innovations" in instructional technology have come and gone over the years. Many of these have been promoted as something that will revolutionize the way education is conducted, however, most have had little impact on the way education is delivered. Among the latest "high-tech" devices are microcomputers and laser videodiscs.

Although microcomputers video tape and laser videodisc technology have been available for a number of years, several factors have prevented widespread applications in education. Among these factors are: lack of information about the technology, the relative high-cost of hardware, software development costs, difficulty of interfacing videodisc players to microcomputers, and the lack of availability of videodisc materials which have been specifically designed for instruction.

This presentation provides an overview of the current state-of-the-art of microcomputer assisted instruction, video technology, and interactive videodisc technology in hopes of stimulating awareness and the future development of materials that will improve the delivery of instruction.

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BACKGROUND

We have all seen instructional gimmicks come and go about as fast as a speeding salesman. It would be reasonable, therefore, to consider any new instructional technology, especially when it's promoted with the degree of "hype" that has accompanied microcomputers, video, and laser discs. It seems only reasonable and prudent to approach these things with some skepticism, and to consider their application in terms of what we know about delivering instruction. Therefore, before dealing with the specifics of advanced instructional technologies, and before deciding if they have the potential to improve instruction, let's briefly review the nature of instruction and instructional technology.

Technical education and training had its beginnings in the apprentice system. Young men were assigned to a skilled craftsman, and were called upon to assist him in tasks of slowly increasing complexity as the apprentice observed the master and acquired skills and knowledge of his own. If we put aside for the moment consideration of the morality and ethics of assigning a young person to a sometimes indefinite period of servitude without consent, we might conclude that the apprentice training system had many instructional benefits. It was truly individualized. The learners all had the benefits of the personal attention of the master, and got a great deal of hands-on experience.

As society, population, and technology underwent changes, education moved from the master's workshop with its small number of learners, to the large-scale public institutions we have today. Instructional technology became increasingly important as educators had to abandon the "show them, watch them, show them" approach of the apprentices' masters. Probably the first instructional delivery system used for simultaneously providing instruction to large numbers of students was the lecture. The lecture method, in spite of years of educational research demonstrating that it is one of the least effective instructional strategies, remains one of the most common methods of instruction. The primary reasons for this, I believe, are economics and laziness. Lecturing to a large group of students is relatively inexpensive. And, an average instructor can "wing" a socially acceptable lecture with no more preparation than thinking a little about the subject on the way to class.

LEARNING THEORY

Without getting into an academic discourse on research in learning theory, I would like to reflect on several, almost "common sense", principles of learning. One is that the more senses the learner is required to use, the more the learner retains. Research has shown that individuals retain about 10% of what they read, 20% of what they hear, 30% of what they see, and 50% of what they see and hear (2). Furthermore, when the learner is required to immediately complete an action that demonstrates what the learner has seen and heard, there is a dramatic increase in retention. It should be no surprise that research shows the lecture to be an ineffective (even though economical) means of delivering instruction.

Movies and television, although attacking more senses than lectures, do not require the active participation of the learner. Computer assisted instruction, when properly designed, does require the active participation of the learner. Computer assisted instruction, however, even on prohibitively expensive main-frame computers, cannot compete with color slides for visual impact, or movies or television for motion and sound. Color slides can be mixed with audio tape, or with a live presentation, to enhance instructional delivery. However, for an instructor to maintain and transport a library of several thousand, or even several hundred color slides, is a considerable undertaking that only a few dedicated souls would consider.

INSTRUCTIONAL TECHNOLOGY

Regardless of the presence or absence of research on the effectiveness of various instructional technologies, application of these technologies by instructors seems to be directly related to ease of use. Instructors will use a chalk board as long as it's fixed to the wall, and as long as they don't have to bring their own chalk. Overhead projectors are in common use, although more often than not the visuals used are typed, single-spaced pages full of information, unreadable to anyone sitting beyond the first two rows (which students, and audiences rarely seem to occupy).

Many instructors are rightfully skeptical of new instructional technologies because they have observed so many fads and fancies presented by salespeople as the last word in delivering instruction faster, cheaper, and easier. Some instructional delivery systems have solid educational research supporting their use, but are impractical simply because they are too expensive to obtain or maintain. Such is the case of the PLATO system of computer assisted, computer managed instruction developed in the 1960's and 70's. PLATO was developed with large grants from the National Science Foundation. Quite a number of the more than 10,000 lessons developed for PLATO were proven effective by various educational researchers. However, at $1,200 per student work station per month, the system was too expensive for most institutions.

Just because a lot of audio-visual aids have been less than revolutionary in the past, however, is not sufficient to keep us from considering other technologies as they become available. But, in considering any new instructional technology, such as interactive videodiscs, we should consider it in the context of what we know about learning theory, and with attention to economic practicality.

MICROCOMPUTERS IN EDUCATION

The microcomputer revolution is in full gear. Microcomputers have found their way into an increasing number of aspects of American life. For those in education, however, microcomputers offer both promise and problems. On the one hand, microcomputers can provide significant time savings in the completion of many normal teaching tasks. On the other, they can cause frustration as teachers must revise curricula or teaching plans to accomodate a very volitile technology. It is useful in times like these to step back and take a new look at what affect microcomputer technology can, or should, have on our lives. Since the impact of microcomputers is so pervasive we must consider several completely different areas where microcomputers may affect education.

A TEACHER'S AID:

Perhaps the easiest way to use microcomputers to advantage is to use them as a teacher's aid. Anyone who has spent hours at the end of a grading period calculating totals, averages, and distributions of grades is a prime candidate for a microcomputer. I can tell you from first hand experience that a simple program I wrote to display a graph and calculate averages of exam scores has saved hours of calculator poking time. It has also provided a statistical analysis of quiz results that was previously unthinkable because of time constraints. There are now commercial grade record keeping packages available that can ease the busy work burden on teachers. The microcomputer in this case becomes sort of a clerical robot for the teacher.

Another application of the microcomputer as a teacher's aid is that of an audio visual device. If a classroom is equipped with television monitors, the teacher can use the microcomputer as a slide or overhead projector. Title slides that take several days to get ready using a conventional 35mm camera, can be prepared and used in minutes. These can replace those overhead projector transparencies that cannot be read past the second row. Microcomputer graphics can be generated to illustrate various principles. These can even include annimations (which are hard to do with 35mm slides or overheads). Applications of microcomputers as audio-visual devices, although frequently overlooked by teachers, can do much to enhance the delivery of instruction.

Virtually every brand of microcomputer hardware can, through the use of a modem, be used as a computer terminal to access educational data bases such as ERIC, to access large educational computer systems such as PLATO, and to communicate with teachers around the country through networks such as Compuserve or the Source. Through the use of these networks, teachers have easy access to a tremendous wealth of information. It is possible for teachers from widely separated geographic areas to be in contact with each other on a daily basis rather than once or twice a year.

The problem with implementing microcomputers as instructional aids is finding time to develop software, redo grading systems, or just learn about all the options available. Once a bucket is full you cannot add anything without something spilling out. Most teachers already have a full schedule just trying to survive. The problem with using microcomputers to save time is that it takes time to get them up and working, and this time is hard to come by. The solution is for instructors to lobby their administrators for released time to allow for the development and debugging of the required systems and software. The case must be made that to use microcomputers to save time an initial investment in time is required.

AN ADMINISTRATOR'S AID

Microcomputers are as an important a tool for educational administrators as they are for the thousands of business managers in large and small companies across the country. The initial application of microcomputers in business, was through the use of spread sheet programs. The ease of doing "if-then-what" analyses with programs such as Visicalc, Supercalc, or Lotus 123 has dramatically changed the way many businesses operate. Many of these same programs can be applied to education. When I was at the National Center for Research in Vocational Education, I helped implement the use of a spread sheet program in the preparation of budgets for project proposals. The turn-around time for calculating or revising a project budget went from days to hours.

In addition to applying microcomputers to the normal business functions of an institution, administrators could take advantage of the communications capabilities of microcomputers. By establishing an administrator's "bulletin board", administrators could be in constant communication with each other as well as with state education officials.

PROFESSIONAL TOOLS

Anyone who has not been asleep for the last several years is aware that microcomputers are playing an increasing role in business and industry. Microcomputers, as a tool of the profession, must by necessity become an increasing part of our instructional content. Some would refer to the need for "computer literacy" on the part of our students. One should not jump to the conclusion, however, that computer literacy in the context of education means that all students should know how to get a list of files on an Apple II. What is needed is the traditional approach in dealing with the new microcomputers as simply new "tools of the trade" in the various educational discliplines. The sensibile traditional approach is to rely on advisory committees from the disclipline to identify specific computer literacy requirements in each program area.

AN INSTRUCTIONAL DELIVERY SYSTEM:

Another area of microcomputer applications that I would like to touch on is that of using the microcomputer for computer aided instruction (CAI) or computer managed instruction (CMI). Using the microcomputer as an instructional delivery system allows for practical individualized instruction. To do this requires that each student have access to a computer, but with the cost of significantly sophisticated systems starting at less than $1000, it is concievable to consider providing each student with a computer.

The problem in using microcomputers for CAI is that of developing or finding good software. Developing good CAI materials is time consuming and expensive. It takes anywhere from 200 to 500 hours of effort to develop 1 student contact hour of CAI materials. Most teachers cannot justify this kind of time to develop materials for their class. Most teachers, in fact, are not equipped to develop extensive CAI materials on their own. To do the job properly requires a team consisting of a subject matter expert, a curriculum development expert, a learning theory specialist, and a programmer. This is partly why the major publishers have not introduced very many complete courses as CAI packages. There are a number of small lesson packages available from the publishers, however, how is a teacher with limited free time supposed to evaluate the relative merits of the various software packages and select the best one for the students? Again we see the need for released time for teachers to deal with applications of microcomputers. There may also be a role for professional organizations and teacher training institutions to increase their efforts to engage in software evaluation, and to communicate the results with the teaching community.

VIDEO TECHNOLOGY

Instructional television and video tape nave been around for quite a while. There have not, however, been widespread applications of this technology in regular classrooms. The reason for this I believe, has been cost and complexity. Both of these stumbling blocks are being removed. With the advent of inexpensive video tape recorders and cameras in the consumer market, it is now possible to concieve of a camera and video tape player in every classroom. Simply owning a camera and tape recorder will not make television producers, however. I expect that the most effective uses of video technology in the classroom will be playback of professionally produced video tapes, and the use of video cameras to replace overhead or slide projectors. The incorporation of digital technology into video tape players now allows easy remote control of digital still frames, slow (or strobe) motion, and reverse action. This provides powerful new tools for the instructors bag of teaching tricks.

INTERACTIVE VIDEODISC TECHNOLOGY

The major type of videodisc technology used in instruction is the optical laser disc. There was another system, CED, which still causes some confusion. The CED system, now abandoned by RCA, used a stylus (much like a very fine phonograph needle) which followed grooves on the surface of the disc. There are several problems associated with this approach. For one, it is not possible to randomly access individual frames on the CED disc, or to "freeze" on one frame for an indefinite amount of time. Although CED discs were inexpensive to reproduce, they were largely restricted to a continuous play mode, much like a movie. Because the stylus and grooves are subject to wear, the expected life of both the stylus and the CED disc is fairly short.

OPTICAL LASER DISCS

The optical laser disc uses a narrowly focused beam of light reflected from a surface containing microscopic pits. Since nothing but light contacts the disc surface, wear on discs or disc players is not a factor. Laser discs are made in two formats, controlled linear velocity (CLV) and controlled angular velocity (CAV). CLV discs allow for up to 60 minutes of television, with stereophonic sound. CLV discs essentially compete with movies as an instructional medium. CAV discs allow for the storage of up to 30 minutes of television, with stereophonic sound. CAV discs, however, also allow the capability of complete random access to any of the possible 54,000 individual frames on the disc, and the capability of "freezing" indefinitely on any single frame. This means that it is possible to store the equivalent of 54,000 color slides in the space of an LP phonograph record, and to access any one of them in a worst-case search time of less than 2 seconds. It is also possible to mix still frames and motion sequences. The motion sequences are displayed at 30 frames per second. Still and motion sequences may be stored on the same disk in any combination that adds up to a

total of 54,000 frames. The CAV disk holds two channels of audio. These may be used to contain either stereophonic sound, or completely separate audio tracks. An application of the separate audio track feature would be to provide a choice of different languages, or different levels of explanation with the same video.

It should be noted that when the videodisc player is used to freeze on a single frame of video, the audio is not available. However, several manufactures are marketing various devices to provide "compressed audio" for use with still frames. One of these devices allows over 100 hours of audio on one disc.

Laser videodisc players are classified into three levels. Level one players, such as the Pioneer LD-V2000, have a controller which allows the user to directly control functions such as: playback, search, freeze-frame, slow motion, forward, reverse, or fast scan. Some models can read chapter, stop, or scan codes if they are encoded on the disc. Level-two players, such as the Sony LDP-1000, or the Pioneer LD-V6000, have built-in microprocessors that allow some degree of programming. Controlling programs can be encoded directly on the disc, and are automatically loaded and executed when the player is turned on. This type of videodisc player is being used in training applications in the military and in private industry. Level-three systems consist of either level-one or level-two players coupled with a computer. Level-three systems, therefore, generally form the basis for what is commonly referred to as interactive videodisc technology. The most sophisticated level-three systems also provide for superimposing computer generated video directly over videodisc supplied video. Complete level-three systems are currently being marketed by a number of large companies such as the Sony View system, Digital Equipment Corporation Isis, National Cash Register InteracTV, IBM InfoWindow, and the recently introduced Pioneer LD/VS1. Other Level III systems are being created by assembling a system of components from different manufactures. The most promising of these may be built around the Commodore Amiga computer with its superior video display capability and computing power.

Some people have defined Level-four systems to include input/output devices in addition to a computer. A very clever demonstration of this type of system is a welding simulation. This system uses a videodisc player, a computer, a horizontally mounted television monitor with a touch sensitive screen, and a welding torch that has a photo electric eye and potentiometers instead of the usual oxy-acetelene mixture. As the controls are adjusted on the simulated torch, the computer causes the disc player to display photos of the kind of flame the torch would have with each adjustment of the controls. As a rod of filler metal is moved over the touch screen, a picture of a weld is displayed which is appropriate to the position of the rod. The photo electric eye detects how far the torch head is from the screen and the computer causes the disc player to display a picture with the appropriate characteristics of a weld in process. By this means the student can experience the look and

feel of welding without the cost and danger associated with the real thing. Once the proper level of skill has been developed, the student moves on to actual welding. Similar simulations have been created for first-aid and other medical instruction.

Videodiscs are significantly different from video tape in a number of ways. The advantage of disc over tape is in the area of fast random access, picture quality, durability, freeze frame and step frame capability, and ease of use. The disadvantage of disc compared to tape is in production. Videotape is both a playback and record medium, while videodiscs are playback only. It should be noted that videodisc recorders (sometimes referred to as "direct-read-after-write devices) are available, but are currently very expensive (starting at about $20,000).

THE GOOD NEWS!

INTERACTIVE VIDEODISCS AS AN INSTRUCTIONAL DELIVERY SYSTEM

Let's review how interactive videodisc systems stack up against our analysis of learning theory. To be effective in increasing long-term retention, an instructional delivery system should allow us to attack as many of the learner's senses as possible. The system should allow for the learner to be actively, rather than passively involved. Interactive videodisc systems can provide text, audio, and visual materials in a manner previously unavailable. The systems can allow the merging of the best of the worlds of audio-visual aids and computer assisted instruction. Interactive videodisc systems have the potential of being the most effective delivery system short of the master craftsman individually training each apprentice.

But what about the cost? We should remember that even though computer assisted instruction on systems such as PLATO has been proven to be educationally effective, the cost of the required hardware can prohibit large scale application. Videodisc systems are not yet inexpensive (although videodisc players have recently been advertised, in a Columbus, Ohio newspaper, for less than $300). The trend is promising, however. In 1982, commercial-grade videodisc players cost about $3500 each. In 1985, players with more capability than the 1982 models are priced at less than $1000. Complete interactive systems are currently priced from $5500 to $12,000. Based on observed trends I expect complete interactive Level-three systems, with video overlay capability, to be priced at less than $2500 per work station within one year. If this estimate is close to correct, we should have large numbers of interactive videodisc systems in schools and universities by 1990.

AND NOW THE BAD NEWS!

VIDEODISC AND SOFTWARE PRODUCTION

The biggest problem in using interactive videodisc systems in education is the lack of availability of both appropriate videodiscs and CAI software. Since videodiscs cannot be produced as simply as videotapes, the average educational institution is unable to develop original videodiscs. The process for developing videodiscs is to first generate a high quality one inch video tape, and then send it to one of a limited number of disc production facilities for generating the master disc and multiple copies. The result is that in small quantities, the per copy cost is fairly high. If more than 100 copies of a disc are made, the cost per disc is less than the per copy cost of videotape. Producing an original disc is no easy matter. If, for example, an instructor wanted to take advantage of the capacity of the disc and put 54,000 separate color slides on the disc, the slides would first have to be made or obtained. Then, they would have to be copied onto a master video tape. This might cost as much as one dollar per picture. You don't have to be much of a mathematician to see that it would cost more than the average instructor has in the petty cash fund. This only speaks to the cost of putting material on the disc. Before this can even be started, a great deal of planning must be done. This requires time, which is simply another way of saying it costs money. The cost to develop a typical educational videodisc ranges anywhere from $50,000 to $200,000. For a good description of the videodisc development process, you might want to review a chart prepared by WICAT Systems, and published in Byte magazine. Even an institution with a large number of students would find it hard to justify the per student cost of developing a videodisc. Although the cost of videodisc hardware has been dropping, and is expected to continue to drop, the cost of videodisc development is unlikely to decrease dramatically. The current introduction of video still cameras and recorders will definitely result in decreasing the cost of collecting large volumes of color photos, and copying them on to video discs.

So far we have only looked at disc production costs. Before the disc can be merged with a computer to complete the interactive system, computer assisted instruction software must be prepared. The literature asserts (and the author's experience has verified), that it takes anywhere from 200 to 500 hours to develop 1 hour of computer assisted instructed software. For the equivalent of a forty hour course, it costs an average of $200,000 to develop a complete computer assisted software package. One of the reasons for this high cost is that to develop good instructional software, it takes a team of people including: a content area specialist, a media expert, someone familiar with learning theory, a curriculum development specialist, and a programmer. The use of higher level authoring languages can reduce the need for programmers, but at the expense of using up computer memory and reducing flexibility in the software.

The only way likely to make the per student cost of videodisc and software development reasonable, is to spread the development costs over significantly large numbers of students. This means developing materials that are used in large numbers of institutions. Before this will nappen, instructors will have to be willing to accept curriculum and materials developed outside of their own institution, or materials that have been developed through the efforts of consortiums.

THE FUTURE?

Ever since I saw a videodisc player in action, I have dreamed of a videodisc with every audio-visual aid that I can imagine for every different subject taught. Teachers would be able to access, within a few seconds, illustrations for every topic they teach simply by pressing a few buttons. I imagine large visual data bases from which random individualized quizzes could be generated. I can see pictures illustrating various processes and procedures. Not just a photo of machines, but sequences of photos that show, step by step, how the machine works. Once you gain a feel for the potential capacity and applications of interactive videodisc technology, the head seems to spin and dance with exciting possibilities for enhancing instruction. The first problem in having this dream come true is the availability of the appropriate videodiscs. The second is the availability of the instructional software that uses the disc.

To properly develop a series of videodiscs for all subjects in education would not be a simple undertaking. It probably would not be something a single institution could or should undertake. To be cost-effective, the development expense must be spread over large numbers of students. To make any dream of the development of a voc-tech disc series come true will probably require the establishment of a consortium of agencies. I have some ideas about this, and would be glad to talk to anyone interested in such a project. By the way, I shouldn't leave you with the impression that instructional videodiscs are not yet available. In fact, the Minnesota Educational Computing Corporation has published a directory listing about 300 videodiscs that are currently available.

SUMMARY

It would appear from our brief review of learning theory that interactive videodisc technology can resolve many of the problems related to delivering high quality instruction to students. The hardware has been developed. The cost of hardware is at a point where it is no longer a stumbling block. The biggest problem to be solved is the development of videodiscs and related computer software. As more and more educators learn about the potential of interactive videodiscs, the demand for quality materials will grow, and there will be corresponding growth in the supply. Hopefully, it will not be too much longer before every student will have the benefits of this most advanced instructional technology.

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BEST RECENT OVERVIEW OF VIDEODISCS IN EDUCATION

Laser Videodiscs in Education: Endless Possibilities by Royal Van Horn. May, 1987 Phi Delta Kappan

VIDEODISC SOURCE INFORMATION and SUPPLIERS

Hearlihy & Co. 714 W. Columbia St. Box 869 Springfield, OH 45001 ph 513-324-5721 Hearlihy sells supplies for Engineering Drawing and CAD instruction.

Hitachi Sales Corp. of America 401 West Artesia Blvd. Compton CA 90220 ph 213-537-8383

Matrox Electronic Systens Ltd. 1055 St. Regis Blvd. Dorval, Quebec Canada H9P 2T4 Matrox currently has the contract to supply videodisc systems to the Army which use the EIDS (Electronic Information Delivery System) standard.

Metamedia Systems Inc. Online Computer Systems Inc.; These closely related companies provide both hardware (Online) and software (Metamedia) for custom videodisc training applications. 20251 Century Blvd. Germantown, MD 20874

Nebraska Videodisc Design/Production Group, University of Nebraska, Box 83111, Lincoln, NE 68501 This group conducts frequent workshops on videodisc production.

Panasonic Industrial Co. One Panasonic Way, Secaucus, NJ 07094 ph 201-348-7337 Panasonic markets videodisc recording systems.

Pioneer Communications, Industrial Electronics Division, Sherbrooke Office Center, 600 East Crescent Ave. Upper Saddle River, NJ 07458-1827 ph 201-327-6400

Sony Corporation of America, Sony Drive Park Ridge, New Jersey 07666 ph 201-930-1000

3M Optical Recording Project 223-5S 3M Center, St. Paul. MN 55144

THE Journal, Annual Source Guide of High Tech Products for Education. THE Journal, Information Synergy Inc. 2626 S. Pullman, Santa Anna, CA 92705

The Videodisc Monitor. a monthly publication of Future Systems, Inc. Box 26, Falls Church, VA. (about $200 per year)

Videodiscs for Education-A Directory, Minnesota Educational Computing Corporation 3490 Lexington Ave North, St Paul, MN 55126

Ztek Co. Offers a free catalog of videodisc products. Ztek Co. 1330 S Third St. Box 952, Louisville, KY 40201, 606-233-7186